

1 ROUTE GUIDANCE SYSTEM

2

3 Background Of the Invention

4

5 In-vehicle route guidance systems are known.
6 However, such systems typically include their own
7 on-board map databases. Since large amounts of data
8 are generally required to describe maps, traditional
9 in-vehicle route guidance systems generally include
10 storage devices with substantial storage capacities
11 to hold the relevant map data.

12

13 European Patent Application EP 1262936 describes a
14 route guidance system comprising an in-vehicle
15 device and a central route advisory system. EP
16 1262936 describes how the driver of a vehicle
17 contacts the central route advisory system and
18 indicates a required destination. The central route
19 advisory system is also informed of the current
20 position of the vehicle by the in-vehicle device.
21 The central route advisory system determines the
22 optimal route to the required destination and

1 transmits details of the route to the in-vehicle
2 device in a single compressed data message.

3
4 EP 1262936 further describes how during the journey,
5 the in-vehicle device issues audible instructions to
6 the driver as the vehicle passes route key-points
7 along the optimal route. The instructions advise
8 the user of future manoeuvres which the user will be
9 required to undertake at junctions, roundabouts etc.

10

11 Summary of the Invention

12

13 According to the invention there is provided a route
14 guidance system comprising an in-vehicle device and
15 a central route advisory system in which the in-
16 vehicle device comprises an audio emitter and a
17 visual display unit adapted to provide audio and
18 visual instructions to a user to perform manoeuvres
19 required to complete an optimal route, wherein the
20 optimal route is transmitted by the central route
21 advisory system to the in-vehicle device in response
22 to a route request from the user to a human operator
23 in the central route advisory system to a specified
24 destination.

25

26 Preferably, the visual display unit is a monochrome
27 display.

28

29 Preferably, the system comprises a means for
30 displaying on the visual display unit a junction or
31 roundabout as the vehicle approaches it.

32

1 Desirably, the system comprises a means for
2 displaying on the visual display unit junctions as
3 pictographs.

4
5 Desirably, the system comprises a means of
6 displaying on the visual display unit roundabouts as
7 pictographs.

8
9 Preferably, the system comprises a means for
10 indicating on the displayed pictograph the required
11 manoeuvre.

12
13 Preferably, the system comprises a means for
14 supplementing the visual instructions to perform a
15 manoeuvre with audible instructions to perform a
16 manoeuvre.

17
18 Desirably, the visual display unit provides a means
19 of initiating an automatic route request in respect
20 of a stored destination.

21
22 Desirably, the system comprises a means for
23 displaying on the visual display unit the proximity
24 of speed-cameras.

25
26 Alternatively, the visual display unit is a colour
27 display unit.

28
29 Preferably, the system comprises a means for
30 displaying on the colour display unit coloured road-
31 maps of a particular region.

32

1 Preferably, the system comprises a means for
2 superimposing onto the coloured road-maps the
3 current position of the car.

4
5 Preferably, the system comprises a means for
6 superimposing onto the coloured road-maps the
7 pictograph of a junction or roundabout.

8
9 Desirably, the system comprises a means for
10 providing a user-interface on the colour display
11 unit and a means for enabling the user to make
12 telephone call.

13
14 Desirably, the system comprises a means for
15 providing a user-interface on the colour display
16 unit and a means for enabling the user to receive a
17 telephone call.

18
19 Preferably, the system comprises a means for
20 providing a user-interface on the colour display
21 unit and a means for enabling the user to receive a
22 text-message.

23
24 According to a second aspect of the invention there
25 is provided a route guidance system comprising an
26 in-vehicle device and a central route advisory
27 system in which the in-vehicle device comprises
28 units adapted to provide instructions to a user to
29 perform manoeuvres required to complete an optimal
30 route, wherein the optimal route is determined by
31 the central route advisory system using real-time
32 historical traffic data acquired from monitored

1 routes together with archive data acquired from non-
2 monitored routes and transmitted by the central
3 route advisory system to the in-vehicle device in
4 response to a route request from the user to a human
5 operator in the central route advisory system to a
6 specified destination.

7
8 According to a third aspect of the invention there
9 is provided a route guidance system comprising an
10 in-vehicle device and a central route advisory
11 system in which the in-vehicle device comprises
12 units adapted to provide instructions to a user to
13 perform manoeuvres required to complete an optimal
14 route, wherein the optimal route is calculated by
15 the central route advisory system using a traffic
16 forecasting model and transmitted by the central
17 route advisory system to the in-vehicle device in
18 response to a route request from the user to a human
19 operator in the central route advisory system to a
20 specified destination.

21
22 Preferably, the traffic forecasting model is time
23 dependent.

24
25 Preferably, the central route advisory system
26 comprises a means for predicting future traffic
27 conditions based on the time at which the route
28 request was received together with the time
29 dependent traffic forecasting model.

30
31 According to a fourth aspect of the invention there
32 is provided a route guidance system comprising an

1 in-vehicle device and a central route advisory
2 system in which the in-vehicle device comprises
3 units adapted to provide instructions to a user to
4 perform manoeuvres required to complete an optimal
5 route, wherein the optimal route is calculated by
6 the central route advisory system taking into
7 account the previous travelling direction of the
8 vehicle, in response to a route request from the
9 user to a human operator in the central route
10 advisory system to a specified destination, and the
11 optimal route is transmitted by the central route
12 advisory system to the in-vehicle device.

13

14 According to a fifth aspect of the invention there
15 is provided a route guidance system comprising an
16 in-vehicle device and a central route advisory
17 system in which the in-vehicle device comprises
18 units adapted to provide instructions to a user to
19 perform manoeuvres required to complete an optimal
20 route, wherein the optimal route is calculated by
21 the central route advisory system taking into
22 account the previous travelling direction of the
23 vehicle, in response to a route request from the
24 user to a human operator in the central route
25 advisory system to a specified destination, and the
26 optimal route is transmitted by the central route
27 advisory system to the in-vehicle device.

28

29 According to a sixth aspect of the invention there
30 is provided a route guidance method comprising the
31 steps of:

- 1 (a) receiving a call from a user's in-vehicle
- 2 device indicating the user's desired
- 3 destination;
- 4 (b) entering the user's desired destination into a
- 5 route-guidance system;
- 6 (c) determining the current location of the user's
- 7 vehicle;
- 8 (d) determining the potential routes to the desired
- 9 destination;
- 10 (e) ascertaining traffic conditions along the
- 11 potential routes;
- 12 (f) determining the optimal route to the desired
- 13 destination using the distances of the
- 14 potential routes and the traffic conditions
- 15 along the routes;
- 16 (g) establishing route key-points along the optimal
- 17 route;
- 18 (h) associating flags with the route key-points;
- 19 (i) transmitting the route key-points and flags to
- 20 the user's in-vehicle device; and
- 21 (j) providing visual and audio instructions to the
- 22 user as the user's vehicle approaches the route
- 23 key-points along the optimal route.

24

25 According to a seventh aspect of the invention there
26 is provided a route guidance method comprising the
27 steps of:

- 28 (a) receiving a call from a user's in-vehicle
- 29 device indicating the user's desired
- 30 destination;
- 31 (b) determining the current location of the user's
- 32 vehicle;

- 1 (c) entering the user's desired destination into a
- 2 route-guidance system;
- 3 (d) determining the potential routes to the desired
- 4 destination;
- 5 (e) ascertaining traffic conditions along the
- 6 potential routes;
- 7 (f) determining the optimal route to the desired
- 8 destination using the distances of the
- 9 potential routes and the traffic conditions
- 10 along the routes;
- 11 (g) establishing route key-points along the optimal
- 12 route;
- 13 (h) associating flags with the route key-points;
- 14 (i) transmitting the route key-points and flags to
- 15 the user's in-vehicle device; and
- 16 (j) providing instructions to the user as the
- 17 user's vehicle approaches the route key-points
- 18 along the optimal route.

19

20 According to an eighth aspect of the invention there
21 is provided a route guidance method comprising the
22 steps of:

- 23 (a) receiving a call from a user's in-vehicle
- 24 device indicating the user's desired
- 25 destination;
- 26 (b) entering the user's desired destination into a
- 27 route-guidance system;
- 28 (c) determining the current location of the user's
- 29 vehicle from a dual multi-frequency tone
- 30 transmission from the user's in-vehicle device;
- 31 (d) determining the potential routes to the desired
- 32 destination;

- 1 (e) ascertaining traffic conditions along the
- 2 potential routes;
- 3 (f) determining the optimal route to the desired
- 4 destination using the distances of the
- 5 potential routes and the traffic conditions
- 6 along the routes;
- 7 (g) establishing route key-points along the optimal
- 8 route;
- 9 (h) associating flags with the route key-points;
- 10 (i) transmitting the route key-points and flags to
- 11 the user's in-vehicle device; and
- 12 (j) providing instructions to the user as the
- 13 user's vehicle approaches the route key-points
- 14 along the optimal route

15

16 Alternatively, the current position of the user's
17 vehicle is determined from an ISDN sub-addressing
18 transmission from the user's in-vehicle device.

19

20 According to a ninth aspect of the invention there
21 is provided a route guidance method comprising the
22 steps of:

- 23 (a) receiving a call from a user's in-vehicle
- 24 device indicating the user's desired
- 25 destination;
- 26 (b) entering the user's desired destination into a
- 27 route-guidance system;
- 28 (c) determining the current location of the user's
- 29 vehicle;
- 30 (d) determining the potential routes to the desired
- 31 destination;

- 1 (e) ascertaining traffic conditions along the
2 potential routes;
- 3 (f) determining the optimal route to the desired
4 destination using the distances of the
5 potential routes and the traffic conditions
6 along the routes;
- 7 (g) establishing route key-points along the optimal
8 route;
- 9 (h) associating flags with the route key-points;
- 10 (i) transmitting the route key-points and flags to
11 the user's in-vehicle device;
- 12 (j) using route convergence model to determine the
13 direction in which the user's vehicle is
14 travelling once the vehicle commences the
15 journey along the optimal route;
- 16 (k) providing visual and audio instructions to the
17 user as the user's vehicle approaches the route
18 key-points along the optimal route.

19

20 Preferably, the in-vehicle device uses the route
21 convergence model to display the current route on
22 which the vehicle is travelling.

23

24 Advantages of the Invention

25

26 Audible instructions of the type described in EP
27 1262936 can sometimes be ambiguous or misleading.
28 To overcome this problem, the present invention
29 includes display devices to provide visual aids to
30 supplement the audio instructions provided by the
31 in-vehicle device. These display devices also
32 provide the user with additional information such as

1 a distance count-down to a junction, estimated time
2 of arrival at a destination, proximity of speed
3 cameras etc.

4
5 A first embodiment of the invention includes a
6 monochrome display unit which displays junctions,
7 roundabouts etc. in simple pictographic format. The
8 second embodiment of the invention includes a colour
9 display unit which displays road-maps and depicts
10 the present location of the vehicle on the map. The
11 colour display unit also provides a user interface
12 which enables the user to make and receive voice
13 calls (other than to the call central route advisory
14 system) and to receive text messages.

15
16 The display units also provide user interfaces to
17 the route guidance system and enable a user to make
18 automatic route requests based on the post-code of a
19 destination, or previously stored favourite
20 destinations or previously visited destinations.

21
22 The first and second embodiments of the present
23 invention also includes a mechanism of encoding
24 pictograms representing junctions roundabouts etc.
25 in a data efficient manner so that the resulting
26 data can be readily transmitted to the user's in-
27 vehicle device.

28
29 The fifth embodiment of the present invention
30 employs a novel SMS messaging sequence to the call
31 centre advisory system.

32

1 EP 1262936 used SMS messaging to transmit the
2 vehicle's current GPS position to the central route
3 advisory system. Since SMS messaging may be
4 expensive, the sixth and seventh embodiments of the
5 present invention employ a less expensive dual-tone-
6 multi-frequency (DTMF) system and/or ISDN sub-
7 addressing mechanism for transmitting the vehicle's
8 current location to the central route advisory
9 system.

10

11 EP 1262936 described a route guidance system which
12 combined map information and historical and real-
13 time traffic information to determine the optimal
14 route to a required destination. However, the route
15 guidance system described in EP 1262936 relied
16 entirely on information acquired at the time at
17 which the route request was made. The system
18 described in EP 1262936 did not take into account
19 the fact that traffic conditions are dynamically
20 variable, so that the traffic conditions prevailing
21 at a particular point in time might not be
22 applicable an hour later. The fourth embodiment of
23 the present invention employs a time dependent
24 forecasting model to predict future traffic
25 conditions and in particular to predict the traffic
26 conditions that a driver might expect to encounter
27 on entering a particular route segment. The
28 forecast estimate is determined from the time at
29 which the route request is received by the central
30 route advisory system. The use of the time
31 dependent traffic forecasting model enables the

1 route guidance system to more accurately reflect the
2 dynamic nature of traffic flow.

3

4 Nine embodiments of the invention will now be
5 described with reference to the accompanying
6 drawings in which

7 Figure 1 is a block diagram of the in-vehicle
8 device showing the colour and monochrome display
9 units of the first and second embodiments of the
10 route guidance system;

11 Figure 2 is a block diagram of the hardware
12 components of the central call centre advisory
13 system of the routing guidance system;

14 Figure 3 is a schematic representation of an
15 example scenario demonstrating the function of a
16 confirmation point triplet;

17 Figure 4 is a schematic representation of an
18 example scenario demonstrating the function of
19 benign confirmation points;

20 Figure 5a is a pictogram of a roundabout as
21 would be displayed by the monochrome and colour
22 display units;

23 Figure 5b is a pictogram of a junction as would
24 be displayed by the monochrome and colour display
25 units;

26 Figure 6 is screen shot of the normal display
27 mode of the monochrome display units;

28 Figure 7 is a pictogram of bent variants of the
29 straight ahead arrow denoting bends on the route
30 ahead, as would be displayed by the monochrome and
31 colour display units;

1 Figure 8 is a series of pictograms of compound
2 junctions that would be displayed by the monochrome
3 and colour display units; and

4 Figure 9 is a screen shot of the compass aid
5 screen of the monochrome display unit.

6
7 The following description will first discuss the
8 hardware architecture of the route guidance system.
9 The role and function of route key-points in the
10 route guidance system will then be described
11 followed by a discussion of the route convergence
12 model and the smart start system. The description
13 will finally discuss the software architecture
14 employed in the first and second embodiments of the
15 invention which include the monochrome and colour
16 display units respectively.

17

18 HARDWARE ARCHITECTURE OF THE ROUTE GUIDANCE SYSTEM

19

20 As described in EP 1262936, the route guidance
21 system comprises in-vehicle devices and a central
22 route advisory system. An in-vehicle device is
23 installed in each user's vehicle and communicates
24 with the central route advisory system through a
25 mobile telephone network. An overview of the
26 architectures of the in-vehicle devices and the
27 central route advisory system will be discussed in
28 turn below.

29

30 Referring to Figure 1 and the first embodiment of
31 the route guidance system, an in-vehicle device 10
32 comprises a navigation unit 12 which in turn

1 comprises a GPS (Global Positioning System) receiver
2 14, a mobile telephone device 16 and a memory 19 for
3 the mobile telephone device 16. The navigation unit
4 12 further comprises a speech synthesiser 18, a
5 control microprocessor 22 and an on-board memory 20
6 for the speech synthesiser 18. The memory 20 for
7 the speech synthesiser 18 stores a variety of words
8 and phrases which acts as a vocabulary for the in-
9 vehicle device. The navigation unit 12 finally
10 comprises a memory for storing previous destinations
11 visited by the user 23. The speech synthesiser is
12 coupled to any suitable form of audio emitter, for
13 example, an amplifier and speaker or an existing in-
14 vehicle audio system.

15
16 The in-vehicle device 10 further comprises a
17 monochrome video display unit 24 and its own on-
18 board memory 25. The memory 25 for the monochrome
19 display unit 24 stores the latitude and longitude
20 details of user-defined destinations.

21
22 The monochrome display unit 24 is a 128x64 pixel
23 FSTN LCD, although it will be appreciated that other
24 monochrome display devices could also be used. The
25 monochrome display unit includes a touch-screen
26 comprising eight fixed touch areas. The monochrome
27 display is back-lit with a blue LED edge light which
28 can be dimmed at night for safe viewing at night.
29 The contrast of the monochrome display is
30 automatically adjusted in response to changes in
31 ambient temperature. The monochrome display is
32 connected to the in-vehicle device by a bi-

1 directional RS232 interface and in use is further
2 connected to an ignition switched vehicle power
3 supply.

4
5 In the second embodiment of the route guidance
6 system, the monochrome display unit 24 and its
7 memory 25 is replaced with a colour display unit 26
8 and its memory 27. The colour display unit is 5.7
9 inch diagonal colour QVGA (320x240 pixel) STN LCD
10 incorporating a touch screen, although it will be
11 appreciated that other colour displaying devices
12 could also be used. The monochrome display unit
13 memory 25 and colour display unit memory 27 both
14 also store graphic elements used to construct
15 pictograms in accordance with encoded instructions
16 from the central route advisory system.

17
18 The monochrome display unit memory 25 and colour
19 display unit memory 27 both also store graphic
20 elements used to construct pictograms in accordance
21 with encoded instructions from the central route
22 advisory system.

23
24 Referring to Figure 2, the central route advisory
25 system 30 comprises a navigation server 32, an
26 extraction server 33 and a traffic server 34. The
27 navigation server 32 calculates an optimal route to
28 a destination on receipt of a user request. The
29 optimal route is determined using data from the
30 traffic server 34. The navigation server 32 then
31 transmits details of the optimal route to the
32 extraction server 33 which formats the data for

1 transmission to the user's in-vehicle device as a
2 compressed data message.

3

4 Looking at the relationship between the navigation
5 server 32 and the extraction server 33 in more
6 detail, the navigation server 32 typically expresses
7 a calculated optimal route in NavML (or other
8 suitable route engine output). The extraction
9 server 33 then extracts the relevant information
10 from the NavML (or other suitable route engine
11 output) stream to construct a route_summary message
12 and encodes it for wireless transmission to the
13 user's in-vehicle device.

14

15 Route_summary messages typically include a set of
16 GPS positions of route key-points along the optimal
17 route. In general a number of the route key-points
18 are included in any optimal route spaced at
19 intervals of approximately 1 mile. In particular,
20 route key-points are included at positions along the
21 route where an instruction must be given to the
22 driver, or at positions where it might be possible
23 for a driver to make a wrong-turning or take the
24 wrong exit from a roundabout etc. and thereby
25 deviate from the optimal route.

26

27 As part of the audio-prompting mechanism of the
28 route guidance system, Route_summary messages
29 typically also include a number of flags or tokens
30 which are associated with individual route key-
31 points. The flags are used for selecting individual
32 words or phrases from the in-vehicle device's on-

1 board memory and playing the words or phrases to the
2 driver. The flags trigger the selection and playing
3 of a word or phrase as the vehicle passes an
4 associated route key-point. Consequently complete
5 sentences can be constructed as the vehicle passes
6 successive route key-points.

7
8 A description of the role and function of route key-
9 points will follow the description of the hardware
10 architecture of the route guidance system.

11
12 In the first and second embodiments of the route
13 guidance system, a route-message typically uses
14 information extracted from the NavML (or other
15 suitable route engine output) stream to encode
16 pictograms representing junctions and roundabouts on
17 the calculated optimal route.

18
19 For example, if the optimal route includes a
20 roundabout, details of the roundabout including its
21 structure, required entrance and exit are
22 transmitted in NavML form (or other suitable route
23 engine output) by the navigation server 32. The
24 extraction server 33 extracts the relevant
25 information from the NavML (or other suitable route
26 engine output) stream and encodes it for
27 transmission to the in-vehicle device. The encoding
28 process involves representing the roundabout with a
29 specific binary code recognised by the in-vehicle
30 device.

31

1 As indicated above, the monochrome and colour
2 display unit memory chips 25 and 27 store specific
3 graphic elements for constructing pictograms. In
4 the case of the roundabout example, on receipt of
5 the roundabout identifier from the extraction server
6 33, the display unit memory chips 25 and 27 retrieve
7 the circular graphic component used for representing
8 roundabouts.

9
10 The roundabout graphic element has twelve slots
11 about its circumference. On receipt of a code
12 identifying the required entrance to the roundabout,
13 a linear graphic element is inserted in the circular
14 graphic element at slot zero. Using a clock as an
15 analogy for the circular graphic element, slot zero
16 is located at the six o'clock position. This leaves
17 eleven remaining slots for depicting the potential
18 exits from the roundabout. Linear graphic elements
19 are retrieved from the monochrome and colour display
20 unit memory chips 25 and 27 and positioned in slots
21 around the circular graphic element moving in a
22 generally clockwise direction according to the
23 specific binary instructions transmitted by the
24 extraction server 33. A further code is transmitted
25 by the extraction server 33 to specifically identify
26 the required exit from the roundabout. A similar
27 process is used for encoding and depicting radial
28 junctions.

29
30 Route_messages also typically include textual
31 entries for the names of the required entry and exit
32 roads from any junctions on the optimal route.

1 In terms of the architecture of the central route
2 advisory system 30, the navigation server 32
3 communicates with a traffic repository 36 which
4 stores historical traffic information and road
5 closures data. Historical data is data which has
6 been compiled over a period of time to reflect
7 changes in traffic patterns that occur depending
8 upon the time of day or the day of the month in
9 question (e.g. rush hour traffic varying by day of
10 week and season).

11
12 The navigation server 32 also communicates with an
13 application programming interface (API) 40. The API
14 40 facilitates communication between the navigation
15 server 32 and a map database 42 via requests and
16 responses. The map database 42 contains map data
17 together with real time traffic information and
18 historical traffic information. In effect, the
19 navigation server 32 calculates an optimal route for
20 a user, taking into account the distances to be
21 travelled along different routes and traffic
22 conditions along the routes. Traffic conditions are
23 used to estimate the speed at which a vehicle might
24 be expected to travel along a candidate route and
25 thus the delay that a driver might experience along
26 that route. The inclusion of traffic condition
27 information into the algorithm for determining the
28 user's optimal route is known as "traffic impacted
29 routing".

30
31 In a fourth embodiment of the route guidance system,
32 the route optimisation calculations performed by the

1 navigation server are further enhanced by the use of
2 a time dependent traffic forecasting model. The
3 traffic forecasting model forecasts the traffic
4 conditions that might be expected along a route
5 segment depending upon the time at which a route
6 request was received (T_{req} 44). The forecasting
7 model is designed to be time dependent, so that it
8 can more accurately reflect the dynamic and time-
9 varying nature of traffic congestion.

10

11 Using the time dependent traffic forecasting model,
12 the navigation server adjusts the speeds at which
13 the user might be expected to travel along candidate
14 route segments according to the traffic conditions
15 that might be expected to exist along these route
16 segments. As mentioned above the traffic conditions
17 are forecasted based on the time at which a route
18 request is received (T_{req} 44).

19

20 As a simple example, consider a journey at 5 p.m.
21 for which there are two potential routes to the
22 required destination (i.e. Route_A and Route_B).
23 Suppose Route_B is longer than Route_A. However, let
24 us also suppose that during rush-hour (i.e. 5 p.m.)
25 Route_A is considerably busier than Route_B. In this
26 circumstance a driver might be expected to travel
27 more slowly on Route_A than they might on Route_B.
28 Consequently, whilst Route_B might be longer than
29 Route_A the driver might nonetheless have a journey of
30 shorter duration taking Route_B rather than Route_A.

31

1 Looking at the time dependent traffic forecasting
2 model in more detail, the model generates a forecast
3 from data contained in an averaged historical
4 traffic archive together with a forward calendar.
5 The records contained in the averaged historical
6 traffic archive represent average traffic conditions
7 measured over an extended period (e.g. showing
8 differences between week-day and weekend traffic
9 conditions along a particular route segment). The
10 forward calendar is used by the forecast model to
11 select a record from the historical traffic archive
12 that is most relevant to the date at which the route
13 request is made. The forward calendar can also be
14 used as part of a long-term forecasting system if a
15 route request is made in respect of a future date.
16 A short-term forecast of the expected traffic
17 conditions along a candidate route segment is made
18 by the forecasting model using the selected
19 historical traffic record together with the time at
20 which the route request is made (T_{req} 44) and the
21 real-time current traffic conditions recorded at the
22 time the route request was made.

23
24 In a third embodiment of the invention, the
25 navigation server 32 also communicates with a
26 typical traffic information (TTI) database 38. TTI
27 refers to traffic information relating to un-
28 monitored routes e.g. non-trunk A roads, minor roads
29 and urban streets. The TTI database 38 contains a
30 static data-set that can be used by the navigation
31 server 32 to calculate optimal routes for any time
32 of any day.

1 The data contained in the TTI database 38 are
2 equivalent to the data provided for the monitored
3 roads by the long-term forecast. As there is no
4 real-time data for these roads this data is not
5 updated in real-time to produce a more accurate
6 short-term forecast for these route segments.
7 However, the TTI data can be over-ridden on the
8 occurrence of specific traffic events.

9
10 Without the use of the time-dependent traffic
11 forecasting model, the navigation server 32 can only
12 base its route calculations on the conditions of the
13 route at the time of calculating the route.
14 Clearly, such route calculations do not consider the
15 changes in the traffic conditions on a given route
16 segment that might have occurred between the time of
17 the original route calculations and the time at
18 which the driver reaches the route segment in
19 question.

20
21 In addition to providing route information, the
22 central route advisory system 30 can provide a user
23 with traffic congestion information. Traffic
24 congestion information is acquired by the traffic
25 server from a variety of sources such as roadside
26 speed cameras and traffic reports.

27
28 The traffic server 34 communicates real time traffic
29 information and historical traffic information to
30 the navigation server 32 and additionally transmits
31 historical traffic information to a historical
32 traffic information database 46.

1 The historical traffic information database 46
2 provides a map compiler 48 with historical traffic
3 information. The map compiler 48 formats map data
4 together with real time traffic information and
5 historical traffic information and the standard
6 speed for a given road link. The map compiler 48
7 transmits this information to the map database 42
8 which in effect contains standard default expected
9 speeds (impedances) along road-links.

10

11 The traffic server 32 also communicates with a users
12 database 50. The users database 50 stores user
13 profile data (e.g. user's name & address etc.).
14 This data can be amended in accordance with user's
15 requirements (e.g. by the user through an internet
16 connection or by customer services representatives).

17

18 Taking a more detailed look at the relationship
19 between the in-vehicle device 10 and the central
20 route advisory system 30, in use, a user may use the
21 in-vehicle device 10 to manually contact a call
22 centre operator at the central route advisory system
23 30 and provide his required destination. The
24 operator then supplies the required destination to
25 the navigation server 32.

26

27 The system employs two different approaches to
28 transmitting the vehicle's current position. In the
29 first approach whilst the user is speaking to the
30 call-centre operator, the in-vehicle device's
31 navigation unit transmits its calling line identity
32 (CLI) and the current GPS position of the vehicle in

1 an SMS message to the navigation server 32. The
2 advantage of transmitting the navigation unit's CLI
3 before the voice-call is established is that the SMS
4 message containing the CLI has more time to reach
5 the navigation server 32. However, the disadvantage
6 of this approach is that there is a delay in the
7 establishment of the voice-call. In a fifth
8 embodiment of the route guidance system, a second
9 approach is employed in which the navigation unit
10 transmits the SMS message to the navigation server
11 32 before the voice-call is set up between the
12 driver and the call-centre operator. The advantage
13 of this approach is that there is less delay in
14 establishing a voice-call to a call-centre operator.
15 However, more of the duration of the voice-call is
16 taken up with transmitting the CLI to the navigation
17 server than with the first approach.

18
19 On receipt of the route request, the navigation
20 server 32 calculates the optimal route to the
21 required destination, taking into account the user's
22 preferences and traffic conditions, particularly
23 traffic congestion. As discussed above, the
24 navigation server 32 may also use a time-dependent
25 traffic forecasting model to determine the optimal
26 route for the user.

27
28 The navigation server 32 then transmits a response
29 to the optimal route query in a NavML (or other
30 suitable route engine output) stream to the
31 extraction server 33. The extraction server 33
32 extracts the relevant information from the NavML (or

1 other suitable route engine output) stream and
2 encodes into a compressed data message suitable for
3 wireless transmission to the in-vehicle navigation
4 unit. The compressed data message includes all the
5 route key-points on the optimal route together with
6 flags at associated route key-points for triggering
7 audible manoeuvre prompts to the user. In the case
8 of the first and second embodiments of the route
9 guidance system, the compressed data message also
10 includes encoded pictograms and textual information.
11

12 The communications channel between the in-vehicle
13 device and the central route advisory system 30 is
14 then closed and the extraction server 33 does not
15 communicate any further with the in-vehicle device
16 unless the driver requests a different route to the
17 same or a different destination or traffic
18 conditions have changed since the original route
19 request.
20

21 As described above, as the vehicle progresses along
22 the optimal route and passes individual route key-
23 points a flag may be activated triggering the
24 selection of a word or phrase from the in-vehicle
25 device's on-board memory. The word or phrase is
26 then played to the driver through the speech
27 synthesiser to provide audible prompts of required
28 manoeuvres, oncoming junctions etc.
29

30 In the first and second embodiments of the route
31 guidance system, as the vehicle progresses along the
32 optimal route and passes individual route key-

1 points, pictograms displaying nearby junctions or
2 roundabouts are displayed on the in-vehicle device's
3 monochrome or colour display units, together with
4 visual indications of the required manoeuvre and the
5 names/numbers of the entry and exit routes from the
6 junction or roundabout in question. Further
7 discussions of the manner in which junctions and
8 roundabouts are displayed will follow in the
9 discussion of the software architectures of the
10 monochrome and colour display units.

11
12 Returning to the manner in which the in-vehicle
13 device transmits a route request to the central
14 route advisory system 30, since SMS messaging may be
15 costly, the in-vehicle navigation unit may use two
16 less costly, alternative means of transmitting the
17 current GPS position of the vehicle. In the sixth
18 embodiment of the route guidance system, the
19 navigation unit transmits the GPS position of the
20 vehicle to the navigation server 32 using dual-tone-
21 multi-frequency (DTMF) tones at the start of the
22 user's voice-call to the central route advisory
23 system 30.

24
25 In the seventh embodiment of the route guidance
26 system, the in-vehicle navigation unit transmits the
27 vehicle's current GPS position to the navigation
28 server 32 using ISDN sub-addressing as the voice-
29 call to the central route advisory system 30 is
30 being set up. ISDN sub-addressing may be used for
31 this purpose because the ISDN specification allows
32 for additional characters to be appended to a called

1 telephone number. These characters are usually used
2 for further call routing once a call is connected.
3 However, the number of extra characters that may be
4 appended to a called telephone number is also
5 sufficient to enable the transmission of an encoded
6 geographic location.

7
8 All of the above methods of transmitting a route
9 request to the central route advisory system 30 have
10 relied upon a manual process of establishing a
11 voice-call to the call-centre advisory system and
12 telling the call-centre operator the required
13 destination, whereupon the operator manually enters
14 the required destination into the navigation server
15 32.

16
17 In addition to the above manual voice-call based
18 route request process, the route guidance system can
19 also support a process for automatically making a
20 route request. In particular, the user can use the
21 in-vehicle navigation unit to automatically send a
22 route request to a specified or desired destination
23 to the central call centre advisory system
24 navigation server by using the favourites function
25 or previous destination function.

26

27 ROLE AND FUNCTION OF ROUTE KEY-POINTS

28

29 Route key-points can be classified as preparation
30 points, warning points, instructions points,
31 manoeuvre points and confirmation points. A
32 preparation point is positioned along a selected

1 route before a location where a manoeuvre must be
2 performed by the user to reach the required
3 destination. The purpose of the preparation point
4 is to provide a warning to a driver to prepare to
5 perform the required manoeuvre. A typical audio
6 prompt for a preparation point would be "prepare to
7 turn left in 6 yards".

8 A warning point is positioned closer to the location
9 of the required manoeuvre than a preparation point.
10 A warning point similarly serves to warn the driver
11 that he will be required to perform a manoeuvre
12 soon. However, it should be noted that in the case
13 where a driver might be required to perform a series
14 of manoeuvres within a short distance of each other
15 it might not be possible to place a preparation
16 point and warning point before each manoeuvre.

17

18 An instruction point is placed very close to the
19 location where the required manoeuvre must be
20 performed. A typical audio prompt for an
21 instruction point would be "Please turn left".

22

23 A manoeuvre point is a point along the prescribed
24 route where a manoeuvre must be performed by the
25 driver. These points are used internally by the
26 route guidance system and no instructions are given
27 to the driver as they pass these points.

28

29 There are two forms of confirmation points, spoken
30 and non-spoken. A spoken confirmation point
31 provides audible confirmation to the driver that
32 they have completed a required manoeuvre correctly.

1 A typical spoken confirmation point prompt might be
2 "continue driving for 5 yards".

3

4 A non-spoken confirmation point does not provide an
5 audible prompt to the driver, but instead is used by
6 the route guidance system to ensure that the vehicle
7 is being driven along and has not deviated from the
8 prescribed optimal route.

9

10 Looking firstly at spoken confirmation points, take
11 for example, the situation shown in Figure 3. In
12 this example a car 50 is travelling along a main
13 road 52 from which there are a number of side-roads
14 54a, 54b and 54c. The prescribed optimal route
15 requires the driver of the car 50 to continue along
16 the main road 52. Thus if the driver drives the car
17 50 onto one of the side roads 54a, 54b or 54c, the
18 car will no longer be following the prescribed
19 optimal route and can be said to be "off-route".

20

21 In order to determine whether or not a car has been
22 driven "off-route" (onto one of the side roads), a
23 set of three confirmation points (known as a CP
24 triplet) is positioned around each of the junctions
25 with the side-roads. The CP triplet is designed so
26 that a first confirmation point CP_1 is situated
27 before each junction and the two remaining
28 confirmation points CP_2 and CP_3 are positioned after
29 each junction with CP_2 being positioned closer to
30 the junction than CP_3 .

31

1 CP₁ is known as a pre-junction confirmation point
2 and CP₂ and CP₃ are collectively known as post-
3 junction confirmation points. Two post-confirmation
4 points are used in the CP triplet to introduce
5 redundancy into the "off-route" detection system to
6 cope with mapping and GPS errors in the system. For
7 the example shown in Figure 3, the CP triplet
8 associated with each side road 54a, 54b and 54c are
9 designated with a, b and c superscripts
10 respectively.

11
12 Returning to the example shown in Figure 3, as
13 mentioned previously the car 50 is being driven
14 along main road 52 and is approaching the side road
15 54b. If the car 50 passes CP₁^b and CP₂^b or CP₃^b, it
16 is clear that the vehicle is correctly following the
17 optimal route and has not been driven down the side
18 road 54b. However, if the car 50 passes CP₁^b, but
19 does not pass CP₂^b or CP₃^b, it is clear that the car
20 50 has been driven onto side road 54b and is thus
21 "off-route". In this circumstance, the in-vehicle
22 device issues a prompt to the driver warning him
23 that he has driven off the prescribed optimal route.

24
25 Having so far described the role of spoken
26 confirmation points in CP triplets, the description
27 will now turn to the role of non-spoken confirmation
28 points.

29
30 Consider, for example, the situation shown in Figure
31 4 in which a car 60 is parked by the side of a road
32 62. The road ends in a T-junction 64 and the

1 prescribed optimal route requires the driver to turn
2 left onto the T-junction 64. Under normal
3 circumstances a preparation point, warning point and
4 instruction point would have been positioned before
5 the T-junction, to warn the driver that he is
6 approaching the junction and advising the driver of
7 which direction to turn at the junction. However,
8 given the limits to the resolution of domestically
9 available GPS, it is conceivable that the car 60
10 might have been parked at a position 66 between the
11 instruction point for the T-junction 64 and the
12 manoeuvre point representing the T-junction 64
13 itself. In this case, the driver would not receive
14 an instruction as to which direction to turn at the
15 T-junction 64. To overcome this problem, multiple
16 confirmation points CP_1 to CP_n are spaced at close
17 intervals along the road 62. The route message
18 summary transmitted to the in-vehicle device from
19 the central route advisory centre includes a flag
20 for each of the confirmation points indicating that
21 the driver should be advised to "turn left at the
22 junction". Consequently, even though the car might
23 miss the preparation, warning and instruction points
24 for the junction, the driver will nonetheless
25 receive instructions as to which direction to turn
26 on the junction.

27

28 However, since there may be several confirmation
29 points located between the original parking position
30 66 of the car 60 and the T-junction 64, it would be
31 undesirable to have the same "turn left at the
32 junction" message repeatedly played to the driver as

1 the car 60 passes each of these confirmation points.
2 To overcome this problem, as the car 60 passes the
3 first confirmation point after the parking position
4 66, the driver is prompted to "turn left at the
5 junction" and the remaining confirmation points on
6 the road 62 are converted into non-spoken
7 confirmation points, so that the prompt is not sent
8 to the driver again as the car 60 passes the
9 remaining confirmation points to the T-junction 64.
10 Such non-spoken confirmation points are also known
11 as "benign" confirmation points. An exception to
12 this procedure exists if the vehicle is required to
13 drive across a main road to reach the T-junction. In
14 this case a warning is issued to the user as he
15 approaches the main road.

16

17 THE SMART START SYSTEM AND BRANCH CONVERGENCE MODEL
18

19 As discussed above, any route from a first location
20 to a second location is characterised by the route
21 guidance system by a number of route key-points
22 which include locations at which specific manoeuvres
23 must be performed by the driver (e.g. turn right at
24 the T-junction etc.) or locations at which the
25 progress of a vehicle can be checked to determine
26 whether the vehicle is still on the correct route.

27

28 In general, from any particular starting point there
29 may be many different alternative routes or
30 "branches" to the required destination. As the
31 journey progresses the number of alternative routes
32 to the destination steadily decrease, until all the

1 alternative routes eventually converge into a single
2 "onward route" to the destination. Since each
3 alternative route is characterised by a set of route
4 key-points, the start of any journey is similarly
5 characterised by the presence of a number of
6 different sets of route key-points, one for each
7 alternative route to the destination. As the
8 journey progresses, the process of route convergence
9 is reflected in a steady decrease in the number of
10 sets of route key-points which can be used to
11 describe the journey.

12
13 Consider for example, a car parked on a street. The
14 car may be pointed in one of two directions on the
15 street and thus there are two directions in which
16 the car may progress down the street from its
17 parking position (and thus two potential branches
18 from the starting position). If the car passes a
19 route key-point situated at either end of the street
20 it is possible to determine in which direction the
21 car is travelling and thus the branch corresponding
22 to the direction in which the car did not travel
23 disappears.

24
25 SOFTWARE ARCHITECTURE OF THE FIRST AND SECOND
26 EMBODIMENTS OF THE ROUTE GUIDANCE SYSTEM

27

28 (A) MONOCHROME DISPLAY UNIT SOFTWARE

29

30 The main purpose of the monochrome display unit is
31 to provide user guidance to a user to supplement the

1 audible instructions issued by the in-vehicle
2 device.

3
4 The monochrome display unit has a number of
5 different display modes including a normal display,
6 a compass display, a menu display and a guidance
7 inactive display. These display modes will be
8 described in more detail below.

9 (1) Normal Display Mode

10
11 The information displayed by the monochrome display
12 unit consists primarily of graphical icons
13 representing junctions and roundabouts etc. as seen
14 in Figures 5a and 5b. The purpose of such displays
15 is to clarify ambiguous audible instructions issued
16 by the in-vehicle device.

17
18 The normal screen displayed by the monochrome
19 display unit is shown in Figure 6 and comprises four
20 main sections, namely a target/current road section
21 100, a junction pictogram/straight ahead arrow
22 section 102, a distance countdown section 104 and an
23 information zone section 106. These sections will
24 be described in more detail below.

25

26 (i) Target/Current Road Section 100

27 This section shows the number and/or name of the
28 road that the vehicle is currently on and the number
29 and/or name of the road onto which the vehicle
30 should turn during a manoeuvre. When driving
31 straight ahead the current road will be shown.

32

1 (ii) Junction Pictogram/Straight Ahead Arrow Section
2 102

3

4 This section displays a pictogram depicting a
5 roundabout or radial junction such as those shown in
6 Figures 5a and 5b. The display is initiated when
7 the vehicle passes a preparation point and continues
8 to be displayed during the subsequent manoeuvre.

9 When driving straight ahead, an arrow symbol is used
10 instead of the roundabout/radial junction pictogram.
11 The arrow symbol can be displayed in a variety of
12 curved forms as shown in Figure 7 to reflect changes
13 in road direction.

14

15 Both the radial and roundabout pictograms comprise a
16 central point from which 12 branches are disposed at
17 30° degrees angle relative to each other. The
18 required route through the roundabout or radial
19 junction is highlighted on the pictogram.

20

21 The monochrome display unit also displays pictograms
22 depicting compound junctions, such as those seen in
23 Figure 8. These pictograms essentially comprise
24 assemblies of the roundabout and radial junction
25 pictograms previously discussed.

26

27 If the navigation unit of the in-vehicle device
28 detects that the vehicle has passed an appropriate
29 confirmation point, it is clear that the driver has
30 correctly completed the required manoeuvre and the
31 junction pictogram is replaced by the straight ahead
32 pictogram.

1 (iii) Distance Countdown Section 104

2 This section provides a graphical and/or numeric
3 representation of the remaining distance until a
4 manoeuvre is to be executed (the "manoeuvre point").
5

6 (iv) Information Zone 106

7 This section is used to display the estimated
8 time of arrival (ETA) and distance to the required
9 destination This section can also be used to
10 display warnings to the driver of oncoming speed
11 cameras and to indicate the speed limit in the
12 vicinity of a speed camera.
13

14 **(2) Compass Display Mode**
15

16 At the start of a journey, or in the event that a
17 vehicle deviates from the prescribed optimal route.
18 The normal display (described above) is changed to a
19 "compass" type display as shown in Figure 9
20 comprising an arrow shaped indicator (the compass
21 arrow) of the direction of travel.
22

23 If the vehicle is starting a journey, the compass
24 arrow points towards the first route key-point on
25 the prescribed optimal route and the display
26 provides an indication of the distance to this point
27 and its associated road name.
28

29 As described in an earlier example, in the case of a
30 car starting a journey from a position parked by the
31 side of a road, it is not possible to determine the
32 direction in which the car is pointed and thus,

1 until the vehicle has moved it is not possible to
2 determine the direction in which it is travelling.
3 In this circumstance, the most recent travel
4 direction of the car prior to the present journey is
5 stored by the in-vehicle device and used to
6 calculate the direction in which the compass arrow
7 on the monochrome display should point.
8 In the case where a vehicle has deviated from a
9 prescribed optimal route, the compass arrow points
10 towards the final destination point and an "off
11 route" warning is displayed instead of the road-name
12 of the next route key-point on the prescribed
13 optimal route.

14

15 **(3) Menu Display Mode**

16

17 The touch screen of the monochrome display unit acts
18 as a user interface to the in-vehicle device.
19 Touching the screen activates a menu of functions
20 including:

- 21 (i) Call centre
- 22 (ii) Advanced guidance
- 23 (iii) Mute
- 24 (iv) Repeat
- 25 (v) SOS

26

27 **(i) Call Centre**

28 Activating the call centre function initiates a
29 manual route-request to the call centre advisory
30 system.

31

32

1 (ii) Advanced Guidance

2 The advanced guidance menu option provides access to
3 a sub-menu containing additional guidance-related
4 options including:

- 5 (a) Presets 1 to 9
- 6 (b) Re-route
- 7 (c) Cancel
- 8 (d) Suspend/Resume

9 These options will be discussed in more detail
10 below.

11

12 (a) *Presets 1 to 9*

13 This option allows the selection of destinations
14 that have been preset via a web site.

15 Selecting a destination, causes the in-vehicle
16 device to send an automated request to the call
17 centre advisory system for a route to the
18 destination.

19

20 (b) *Re-route*

21 The re-route option allows a user to invoke a
22 routing call to determine a new route to the
23 currently selected destination. If guidance to the
24 destination is not already in progress, the re-route
25 option is inactivated.

26

27 (c) *Cancel*

28 This option enables a user to abandon route
29 guidance.

30

31

32

1 (d) *Suspend/Resume*

2 Selecting the suspend option causes the in-vehicle
3 device to mute guidance and traffic related audible
4 instructions and suppress pictograms and re-routing
5 advice. In the meantime, the in-vehicle device
6 continues to scan and match route key-points along
7 the prescribed optimal route.

8

9 (iii) Mute

10 This option silences any audible prompt that is
11 being issued by the in-vehicle device.

12

13 (iv) Repeat

14 This option repeats the last audible prompt issued
15 by the in-vehicle device.

16

17 (v) SOS

18 The SOS option allows a user to make a voice call to
19 a preset emergency and/or breakdown telephone
20 number.

21

22 **(4) Inactive Guidance Display Mode**

23 When the user has not requested route guidance (i.e.
24 guidance is inactive), the monochrome display
25 provides general information to the user. The
26 information displayed by the monochrome display unit
27 in such circumstances includes

28 (a) the current time

29 (b) speed camera warnings

30 (c) a graphical compass depicting the current
31 direction of travel.

32

1 (B) COLOUR DISPLAY UNIT SOFTWARE

2

3 In common with the monochrome display unit, the
4 colour display unit is designed to provide visual
5 prompts to a driver to supplement the audible
6 instructions issued by the in-vehicle device.

7

8 The colour display unit is capable of displaying
9 much more sophisticated graphics than the monochrome
10 display unit and in particular is not restricted to
11 pictographic displays but is also capable of
12 displaying coloured road maps showing the relative
13 position of the vehicle and nearby roundabouts and
14 junctions

15

16 As with the monochrome display unit, the colour
17 display unit has a number of display modes.

18 However, regardless of which display mode is
19 activated on the colour display unit, there is
20 always an area reserved at bottom of screen for
21 displaying:

22 (a) the remaining distance to the destination

23 (b) the estimated time of arrival at the
24 destination

25 (c) an indication of whether traffic
26 congestion has been detected within the
27 map area displayed on the screen at any
28 given time

29

30 The display modes of the colour display function
31 include:

32 (A) Map Display Mode

- 1 (B) Guidance Active Mode
- 2 (C) Guidance Inactive Mode
- 3 (D) Help Mode

4

5 The display modes will be described in more detail
6 below.

7

8

(A) MAP DISPLAY MODE

9

10 The principal display mode of the colour display
11 unit is the map display mode. The colour display
12 unit operates in map display mode even if the in-
13 vehicle device does not contain a navigation unit.
14 If the in-vehicle device does not contain a
15 navigation unit the colour display unit does not
16 display any navigation options. When operating in
17 map display mode, the colour display unit displays a
18 road map of the relevant country which can be zoomed
19 to different degrees of magnification in accordance
20 with user demands. In particular, the road maps can
21 be displayed at magnifications between 0.4 pixels
22 per mile (in which the entire UK mainland displayed
23 on the screen) and 100 pixels per mile (wherein the
24 screen width covers approximately 3 miles). At
25 higher levels of magnification, the map display
26 shows motorway and trunk road networks and
27 additional less significant roads.

28

29

30

31

32

1 MAP DISPLAY MODE MENUS

2

3 A number of functions are available to the user when
4 the colour display unit is operating in map display
5 mode, these functions can be divided into

- 6 (1) basic functions
7 (2) advanced functions
8 (3) telephone functions

9

10 The advanced functions include the following:

- 11 (a) a live traffic information function;
12 (b) a current route display function;
13 (c) a junction display function;
14 (d) a compass aid function,
15 (e) an exit indicator function; and
16 (f) a safety camera warning function.

17 All the functions will be described in more detail
18 below.

19

20 1. BASIC MAP DISPLAY MODE FUNCTIONS

21

22 The basic map display mode functions include a
23 vehicle location information function and an auto-
24 locate function. Both basic map display functions
25 will be described in turn below.

26

27 (a) Vehicle Location Information

28 If a navigation unit is installed in the in-vehicle
29 device, the navigation unit can determine the GPS
30 location of the vehicle. The current GPS co-
31 ordinates of the vehicle are used to position a
32 vehicle icon on the currently displayed map, at a

1 point reflecting the current position of the vehicle
2 in relation to the map. The navigation unit can
3 also use acquired GPS data to determine whether or
4 not the vehicle is moving. If the vehicle is moving
5 the vehicle icon displayed on the current map is
6 depicted with an indication of the direction of
7 movement.

8
9 If the navigation unit cannot obtain a valid GPS fix
10 and thereby determine the current location of the
11 vehicle, the vehicle icon is displayed in accordance
12 with the most recent previously determined GPS
13 location of the vehicle. Vehicle icons are displayed
14 in one of two colours to enable a driver to
15 distinguish between vehicle icons displayed using a
16 current GPS fix and those using a previous GPS fix.

17
18 At all levels of zoom apart from the outermost (whole
19 of the relevant country), the map display is
20 provided with a pan option which enables the map to
21 be panned at the same level of zoom in one of eight
22 directions. To facilitate the panning operation, a
23 set of eight pan arrows is always displayed on a
24 map.

25

26 (b) Auto-Locate Function

27 In order to reduce the amount of required
28 interaction between the driver and the controls of
29 the colour display unit, the auto-locate function
30 can be used to automatically pan a displayed map, so
31 that the map tracks the location of the vehicle in

1 accordance with the most recently acquired GPS fix
2 of the vehicle.

3
4 When the auto-locate function is initiated, the user
5 may manually pan a displayed map until the
6 navigation unit obtains a first valid GPS fix for
7 the vehicle. Once a valid GPS fix is obtained, the
8 map is automatically panned so that vehicle is
9 positioned at the centre of the screen. If the
10 vehicle moves, the map is automatically panned to
11 keep the vehicle icon centred on the screen. The
12 zoom level of the map may be changed at any time
13 whilst the auto-locate function is activated, and
14 the auto-scrolling of the map will continue in
15 accordance with the movement of the vehicle.

16
17 If the auto-locate function is de-activated, the map
18 display will continue to update the vehicle position
19 on the map, but the map will no longer be
20 automatically panned in accordance with the movement
21 of the vehicle. Consequently depending on the
22 movement of the vehicle, the vehicle may move
23 outside the range of the currently displayed map, in
24 which case the vehicle icon will disappear from the
25 map display, unless the user manually pans the map
26 to compensate for the movement of the vehicle.

27
28 If the auto-locate function is not enabled, a
29 displayed map can be panned manually to track the
30 movement of the vehicle.

31

1 2. ADVANCED DISPLAY MODE FUNCTIONS

2

3 (a) Live Traffic Information Function

4

5 Traffic congestion is shown on a currently displayed
6 map using icons superimposed on the corresponding
7 locations on the map. The colour of a congestion
8 icon represents the degree of congestion at the
9 particular location relative to the free-flowing
10 traffic state. The number of congestion icons and
11 their distribution on a map indicate the extent of
12 the congestion within the geographical area
13 encompassed by the displayed map. The congestion
14 icon can also include a numeric representation of
15 the average speed of traffic at the affected
16 location, or alternatively a numeric representation
17 of the delay to be expected at the affected
18 location.

19

20 Congestion icons are designed to flash when
21 superimposed on a displayed map, to attract the
22 driver's attention and reveal map detail which may
23 be concealed beneath the icons. All of the
24 displayed congestion icons flash at the same rate.
25 However, when there are delays in both directions at
26 a particular location, the flashing of oppositely
27 disposed icons is sequenced, so that the congestion
28 in each direction is shown separately.

29

30 If a map were to be displayed at a low magnification
31 (i.e. low level of resolution) a normal congestion
32 icon might be shrunk to the extent that it would be

1 too small to be noticed by the driver. To overcome
2 this problem, a specialised LED style congestion
3 icon is used on maps displayed at low magnification.
4 Such LED style congestion icons do not contain
5 numerical information, but are instead colour coded
6 in accordance with the degree of traffic congestion
7 at a particular point.

8

9 (b) Current Route Display Function

10

11 When a route has been downloaded to the in-vehicle
12 device it is displayed as a highlighted trace
13 superimposed on the currently displayed map.

14 Routing information may include roads that are not
15 held in the colour display unit map database and
16 these will be plotted based on vectors supplied by
17 the in-vehicle device's navigation unit. Once the
18 plotted journey is underway the highlighting on the
19 route will be greyed-out as the vehicle proceeds
20 along it.

21

22 In a ninth embodiment of the route guidance system,
23 the current route display function is intimately
24 linked with the previously described smart start
25 system and route convergence model. In order to
26 plot the current route of a vehicle, at any given
27 route key-point it is necessary to select and
28 display the branch which most closely reflects the
29 most recent manoeuvres of the vehicle.

30 Consequently, the current route display function
31 employs a dynamic selection and replotting algorithm
32 to provide a real-time display of the most suitable

1 route for the vehicle to its destination. The
2 process of selecting the most suitable branch for
3 the vehicle can be very broadly described in terms
4 of the following steps:

- 5 (i) Before the navigation unit has determined
6 that the vehicle has reached one of the
7 route key-points, a "default" branch is
8 displayed by the colour display unit
- 9 (ii) Once the navigation unit has determined
10 that the vehicle has reached a route key-
11 point on one of the branches, the current
12 route display function identifies the
13 branch corresponding to the reached route
14 key-point and the colour display unit
15 displays the path ahead to the next route
16 key-point on the branch
- 17 (iii) As the vehicle reaches further route key-
18 points, the current route display function
19 identifies its corresponding branch and
20 displays the path ahead to the next route
21 key-point on the branch.

22

23 If a number of branches emanate from the last route
24 key-point reached by the vehicle, a branch is
25 selected by the current route display function and
26 the next route key-point along the selected branch
27 is determined. The colour display unit then
28 displays the route ahead to the next route key-point
29 on the selected branch. If the vehicle passes this
30 route key-point, the current route display function
31 determines the next route key-point along the
32 present branch.

1 For example, consider the situation in which a
2 vehicle encounters a fork with two potential
3 branches Branch₁ and Branch₂. In this case the
4 current display function selects a branch, e.g.
5 Branch₁ and determines the next route key-point
6 along Branch₁, namely Key_point_{x,1}. The current
7 display unit then displays the route ahead for the
8 vehicle from its current position at the fork to
9 Key_point_{x,1}. If the navigation system determines
10 that the vehicle has passed Key_point_{x,1}, the current
11 display function determines the next route key-point
12 along the branch, namely Key_point_{x+1,1}.
13 However, if the initial route key-point on the
14 selected branch is not passed by the vehicle, it is
15 likely that the driver drove onto the branch which
16 was not selected and displayed by the current
17 display function. In this case, the current display
18 switches to the unselected branch and displays the
19 route ahead to the next route key-point on the newly
20 selected branch. Using the same example as before,
21 should the navigation unit determine that the
22 vehicle did not pass Key_point_{x,1}, the current display
23 function switches to Branch₂ and displays the route
24 from the fork to Key_point_{x,2}. If the vehicle passes
25 Key_point_{x,2} the current display function displays
26 the route ahead to the next route key-point on the
27 branch, namely Key_point_{x+1,2}.

28

29

30

31

32

1 (c) Junction Display Function

2

3 *(i) Simple Junctions*

4 If a driver is approaching a junction, the junction
5 display function displays the junction in a
6 geographically-indicative pictogram similar to a
7 road-sign. The pictograms essentially take the form
8 of the pictograms displayed by the monochrome
9 display unit (see Figures 5a and 5b)

10

11 If a vehicle passes a preparation point (e.g. 1 mile
12 in advance of a motorway junction), a pictogram
13 representing the junction is inset on a portion of
14 the currently displayed map and the navigation unit
15 issues an audible message, warning the driver of the
16 nearby junction. The pictogram includes information
17 identifying the road which the driver should take
18 from the junction and an indication of the current
19 distance to the junction.

20

21 If the vehicle passes a warning point or an
22 instruction point (e.g. 400 yards in advance of a
23 junction) or a confirmation point (between
24 compounded junctions) a full-screen pictogram of the
25 junction is displayed unless suppressed by the
26 driver and a further audible warning message is
27 issued to the driver.

28

29 The full-screen pictogram of the junction includes
30 information identifying the name and/or number of
31 the **exit road** to be taken from the junction,
32 together with an indication of the class of the

1 exit-road. The pictogram also includes information
2 identifying the name and/or number of the current
3 i.e. **entry road** together with an indication of its
4 class. The full-screen pictogram finally includes
5 an indication of the current distance to the
6 junction.

7
8 Once the vehicle has passed the junction, the full-
9 screen pictogram of the junction is removed from the
10 colour display unit and the current map is re-
11 displayed to the driver. Similarly if the driver
12 deviates from the route to the junction, the
13 junction pictogram is removed and the current map is
14 re-displayed to the driver.

15

16

17 *(ii) Compound Junctions*

18

19 The colour display unit is also capable of
20 displaying compound junctions (in a similar way to
21 the monochrome display unit).
22 If successive junctions along a prescribed route are
23 located sufficiently close together it may not be
24 possible to place the normal full complement of
25 preparation points, warning points, instructions
26 points between them and it may be necessary to use a
27 restricted set of such route key-points to advise
28 the driver of the required manoeuvre. For example,
29 if a second turning is positioned within 600 yards
30 of a first turning, it may not be possible to place
31 a preparation point, warning point and instruction
32 point between the turnings and the motorist will

1 have to rely on the warning point and instruction
2 point messages. As the distance between successive
3 turnings decrease, the number of points available
4 for providing messages to users also decrease. In
5 extreme cases, there may not be enough space to
6 place any preparation points, warning points,
7 instruction points between successive junctions.
8

9 In the circumstance where junctions are located so
10 close together that it is not possible to place any
11 route key-points between the corresponding manoeuvre
12 points, the junctions are shown in the full-screen
13 pictogram as a compound series (as shown in Figure
14 8). The colour display unit can display a compound
15 series comprising two junctions of any type or up to
16 two roundabouts combined with one radial junction.
17 As a car approaches one of these compound junctions,
18 the colour display unit displays a full-screen
19 pictogram of the entire compound series. The full-
20 screen pictogram also displays text identifying the
21 name or number of the entry road to the first
22 junction and the name or number of the exit road
23 from the last junction of the compound series. A
24 compound instruction such as "turn right and then
25 immediately turn left" is issued at the instruction
26 point before the first manoeuvre.
27

28 As the car passes through the first junction of the
29 compound series and approaches each later junction,
30 the full-screen pictogram only displays the sub-
31 junction in question.
32

1 To ensure display of the next pictogram as soon as
2 possible after negotiating the first junction, the
3 display reverts to a map once the first candidate
4 route point has been reached after any compound
5 manoeuvre. A maximum of three junctions can be
6 compounded in this manner.

7

8 *(iii) Un-encoded Junctions*

9 Depending on the optimal route determined by the
10 central route advisory system, the driver may merely
11 be required to drive straight through a junction
12 (i.e. neither turn right nor left, nor turn around a
13 roundabout).

14

15 In these cases the navigation server neither encodes
16 speech nor pictograms for the junction and merely
17 places confirmation points around the junction to
18 detect whether the driver has turned on the junction
19 rather than going straight through it and as a
20 result has driven the car "off-route" (i.e. the
21 navigation server only places confirmation points
22 around the un-encoded junctions for off-route
23 detection). These unencoded junctions may be
24 recognised via their "CP-triplet" signature (as
25 previously described).

26

27 (d) Compass Aid Function

28

29 Should a driver lose his way from a pre-defined
30 optimal route, audible instructions to the driver
31 are often not very helpful for assisting the driver
32 to regain his route. Similarly, should the driver

1 change his mind as to his desired destination,
2 audible instructions are not very helpful for
3 enabling a driver to lock on to a new route.

4
5 In these circumstances, the compass aid function
6 provides an indicator in the form of an inset onto
7 the currently displayed map showing a dart pointing
8 to the nearest route key-point marker. On reaching
9 this marker, the optimal route to the desired
10 destination is re-calculated and displayed.

11
12 The processing algorithm for the Compass Aid
13 proceeds as follows:

14 1. While Guidance is active but the vehicle is **not**
15 on-route, on passing a route point the in-vehicle
16 device determines the "best" route key-point within
17 the current scanning window for (re)gaining the
18 prescribed route as follows;

19 2. If there are no candidate route key-points (i.e.
20 none within the speed-dependent matching radius)
21 then a successor of the nearest route key-point is
22 used (see 4 below);

23 3. If candidate route key-points are found (i.e.
24 within the speed-dependent matching radius) then a
25 successor of the candidate with the highest
26 "benefit" (i.e. considering both proximity and
27 alignment) is used;

28 4. In both cases 2,3, the "best" (to be pointed at)
29 is the first route key-point at least 30 yards from
30 the current vehicle position found by tracing
31 successors along the relevant "branch";

1 5. The in-vehicle device calculates the angle
2 between the current GPS heading and the azimuth of
3 the selected "best" route key-point, and sends this
4 angle to the display unit which responds by
5 displaying a dart graphic with 16 possible
6 orientations;

7
8 The compass aid function has two further modes of
9 operation, namely manual and automatic re-routing
10 modes.

11
12 In automatic re-routing mode, once the in-vehicle
13 device detects that the user has driven off a
14 prescribed route, the in-vehicle device initiates a
15 silent call to the central route advisory system (ie
16 without alerting the user). If during the call, the
17 in-vehicle device detects that the user has re-
18 gained the prescribed route, the silent call is
19 terminated without making the user aware of the
20 activities of the in-vehicle device. However, if
21 the in-vehicle device detects that the user has not
22 regained the prescribed route, it issues a beep to
23 warn the user and a new route is calculated based on
24 the current position of the vehicle.

25
26 In manual re-routing mode, if the in-vehicle device
27 detects that the user has driven off the prescribed
28 route, it will issue an audible warning to the user,
29 for example, "no longer on route, please do a U-turn
30 where safe". However, if the user is unable to
31 safely perform the U-turn, the user may manually

1 initiate a re-route request call to the central
2 route advisory system.

3

4 (e) Exit Indicator Function

5

6 Exit indicators provide an enhanced visual
7 indication of the exit direction from roundabouts
8 and radial un-encoded junctions.

9

10 The exit indicators dynamically change according to
11 the movements of the vehicle at the relevant
12 junction. In the case of a roundabout, the exit
13 indicator moves around the circular pictogram
14 (representing the roundabout) as the vehicle itself
15 moves around the roundabout. In the case of a
16 radial junction, the exit indicator is adjusted as
17 the vehicle approaches the junction.

18

19 (f) Safety Camera Warning Function

20

21 The navigation unit uses this function to generate
22 audible warnings to the driver of nearby road-side
23 speed cameras. In addition, the colour display unit
24 displays an icon depicting the camera and an
25 indication of the speed limit relevant to the
26 camera.

27

3. TELEPHONE FUNCTIONS

28

29 Calls to the call centre are not regarded as "user"
30 voice calls because the in-vehicle navigation unit
31 always follows up such calls with a data call to the
32 central route advisory system.

1 The colour display unit provides a user interface to
2 enable a driver to use the in-vehicle mobile
3 telephone device to make and receive conventional
4 voice-calls. The in-vehicle mobile telephone device
5 can also be used to receive text messages which can
6 be displayed on the colour display unit. These
7 facilities are made possible by the telephone
8 functions of the colour display unit.

9
10 The telephone functions can be broadly divided into
11 functions for making and receiving voice calls and
12 functions for receiving and displaying text
13 messages. These functions will be described in more
14 detail below.

15

16 **(a) Voice Calls**

17

18 The telephone: voice calls function enables a user
19 to use the touch screen of the colour display unit
20 as a telephone keypad similar to the keypad of a
21 conventional mobile phone. The colour display unit
22 telephone keypad may then be used as a user-
23 interface to the in-vehicle mobile telephone device
24 to enable the driver to make a voice call to a
25 desired telephone number.

26

27 On activating the telephone option the user is
28 provided with the following functions:

29 **(a) Keypad**

30 Converts the colour display unit touch screen
31 into a telephone key-pad. As a number is
32 entered by the driver, the number is displayed

1 on the colour display unit.

2 (b) **Store and Recall**

3 The mobile telephone device in the in-vehicle
4 device includes a memory for storing up to ten
5 frequently used telephone numbers. Each of
6 these numbers has an associated single digit
7 identifier. The store function enables a user
8 to store a number in the mobile telephone
9 device memory in which case the stored number
10 is automatically allocated a number which acts
11 as its identifier. The user can display a
12 stored number using the recall function
13 together with the single digit identifier. The
14 recalled number can then be dialled using the
15 call function.

16 (c) **Recall**

17 (d) **Call**

18 Submits the number entered by the driver to the
19 mobile telephone device for dialling. If the
20 recipient telephone system is engaged, the call
21 function is switched to a redial mode, until
22 the user exits the telephone function menu.
23 Alternatively, if the call is connected to the
24 recipient, the "store" and "recall" functions
25 are suppressed.

26 (e) **Delete**

27 Removes individual digits from an entry or the
28 entire entry itself.

29

30 The above functions enable a driver to make a call
31 from the in-vehicle device. However, the in-vehicle
32 device may also be used to receive calls from

1 external sources. In this case, the colour display
2 unit displays the telephone number of the incoming
3 call and the driver is provided with the option to
4 accept or reject the call.

5

6 Suppression of Spoken Instructions

7 During a voice call or the ringing of the in-vehicle
8 device's mobile phone (on receipt of an incoming
9 telephone call) the in-vehicle device cannot play
10 audible instructions to the driver because the in-
11 vehicle device's audio output is being used for the
12 voice call. In circumstances such as this, the
13 normal instruction playback functions of the in-
14 vehicle device are suppressed in favour of the
15 ongoing voice call. When it is necessary for the
16 navigation unit to provide guidance instructions
17 etc. to the driver, the navigation unit generates a
18 discreet alert tone, whereupon the driver can use a
19 repeat function to interrupt the voice call (without
20 disconnecting the caller). In this case, the
21 navigation unit temporarily takes over control of
22 the audio system of the in-vehicle device to repeat
23 the instruction to the driver. When the instruction
24 message is completed, the navigation unit releases
25 control of the audio system to the audio system.

26

27 Should the driver not wish to interrupt the current
28 voice-call with the guidance instruction from the
29 navigation unit, the driver may continue with the
30 voice call and once the call has ended, use the
31 repeat function to repeat the last instruction.

32

1 SOS Facility

2 The in-vehicle device software includes an optional
3 facility to enable a user to call for assistance in
4 cases of emergency and breakdown and to transmit an
5 SMS message indicating the location of the caller to
6 the operator of the emergency service. On
7 initiating the SOS call, any active calls to the in-
8 vehicle device (user voice calls, calls to the
9 central route advisory system or route uploads) are
10 terminated immediately.

11

12 (b) Text Messaging

13

14 The in-vehicle can also display text-based
15 information of the following categories:

16 (a) Incident

17 (b) Text Messages

18

19 **(a) Incident Information**

20 Text based "incident" messages may be transmitted to
21 a driver as a supplement to the icon based display
22 of traffic delays. These "incident" messages convey
23 specific incident information, e.g. relating to
24 accidents or road closures. The information is
25 encoded to relate to specific geographical areas
26 within the country and the user will only be alerted
27 to the incident if it is relevant to the currently
28 displayed map area.

29

30 **(b) Text Messages**

31 As discussed above, the in-vehicle device may
32 display received SMS messages. SMS messages from

1 certain designated sources are used solely by the
2 navigation unit and are not displayed to the user.
3 Messages from any other sources are deemed
4 "personal" and displayed to the user. Up to 10 SMS
5 messages may be stored in a non-volatile memory
6 associated with the in-vehicle device mobile
7 telephone.

8
9 Both the textual content of any stored SMS messages
10 and the CLI (phone number) of the caller can be
11 displayed together with an icon indicating whether
12 the message has been read or not.

13

14 **B. GUIDANCE ACTIVE MODE**

15

16 In guidance active mode, the navigation device
17 actively advises the user of the optimal route to a
18 required destination. The touch-screen of the
19 colour display unit thus acts as a user interface to
20 the in-vehicle navigation unit enabling the user to
21 make a manual voice call to the central route
22 advisory system before commencing a journey
23 requesting routing advice to the desired
24 destination.

25

26 Furthermore, the user can use the touch screen of
27 the colour display unit to request a new route to
28 the destination even if the vehicle is progressing
29 along a previously downloaded optimal route to the
30 destination. In this case the navigation unit
31 cancels the old route and continues with the new
32 route.

1 In addition, if the driver has deviated from the
2 previously prescribed route, the driver can request
3 the route guidance system to prepare a new route to
4 the required destination, using the re-route
5 function.

6
7 Finally, the driver can reversibly mute audible
8 guidance or traffic-related instructions. In this
9 case the in-vehicle navigation unit continues
10 scanning and matching route key-points but
11 suppresses off-route re-route processing and the
12 display of junction pictograms.

13 C. INACTIVE GUIDANCE MODE

14
15
16 In the guidance inactive screen mode the user can
17 obtain guidance instructions to a particular
18 destination with making a manual call to the central
19 route advisory system. In this case, route requests
20 are made automatically by the in-vehicle device in
21 accordance with the request of the user.

22
23 In particular a driver may request a route to a
24 destination selected from a set of saved favourite
25 destinations. In this case the selected destination
26 is transmitted to the navigation server (without
27 requiring human operator intervention) and after
28 validating the destination, the server automatically
29 transmits the route to the in-vehicle navigation
30 unit.

31

1 Similarly, the user may request a route to a
2 previously visited destination. In use a navigation
3 unit of an in-vehicle device stores in an on-board
4 memory, the latitude and longitudes of the most
5 recent previously requested destination. When the
6 driver selects the previous destination option, the
7 latitude and longitude of the destination are
8 automatically transmitted to the navigation server
9 which transmits an appropriate route to the in-
10 vehicle device navigation unit.

11
12 It will be understood that since the vehicle's
13 location may have changed since the request was made
14 for a route to the previous destination and the
15 prevailing traffic conditions may have also changed,
16 that the route transmitted by the navigation system
17 server may differ from the route previously
18 suggested to the destination.

19
20 Finally, the driver may identify a destination
21 according to its post-code. In this case the post-
22 code is automatically transmitted to the navigation
23 server (without requiring human operator
24 intervention) and the route is automatically
25 transmitted back to the driver's navigation unit.

26

27 D. HELP MODE

28

29 When the colour display unit is operating in help
30 mode, the user can customise the sounds produced by
31 the in-vehicle device. For example, the user can
32 enable or disable the sounding of a warning tone

1 when a text message is received by the in-vehicle
2 device and can also change the volume of audible
3 warning messages

4
5 Similarly, the user can customise the guidance menus
6 displayed by the colour display unit, so for
7 example, the colour display unit may be directed to
8 display pictographic representations of junctions
9 only and suppress the display of map information.
10 Furthermore, the user can also customise screen and
11 display attributes.

12

13 This invention is not limited to the embodiments
14 herein described which can be varied in construction
15 and detail.